ANALYSIS OF TURKISH SWORDFISH (*XIPHIAS GLADIUS*) CATCH RATES IN THE EASTERN MEDITERRANEAN

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SUMMARY

*Indices of abundance of swordfish (*Xiphias gladius*) from the Turkish gillnet and longline fisheries operating in the eastern Mediterranean are presented for the period 2008-2013. Annual standardized indices were estimated by means of Generalized Linear Modeling techniques and the predictor variables included the Year and, Month of sampling. Gillnet CPUE data suggested the presence of and increasing abundance trend over the period 2008-2010, while not any particular trend was identified from the analysis of the longline data set.*

RÉSUMÉ

*Les indices d'abondance de l'espadon (*Xiphias gladius*) des pêcheries turques opérant à la palangre et au filet maillant dans la mer Méditerranée orientale sont présentés pour la période 2008-2013. Les indices annuels standardisés ont été estimés au moyen des techniques de modélisation linéaire généralisée et les variables de prédiction comprenaient l'année et le mois d'échantillonnage. Les données de la CPUE au filet maillant suggéraient la présence d'une tendance d'abondance à la hausse pendant la période 2008-2010, même si l'analyse du jeu de données palangrières n'a fait apparaître aucune tendance particulière.*

RESUMEN

*Se presentan los índices de abundancia del pez espada (*Xiphias gladius*) de las pesquerías turcas de redes de enmalle y palangre que operaban en el Mediterráneo oriental durante el periodo 2008-2013. Se estimaron índices estandarizados anuales por medio de técnicas de modelación lineal generalizada y las variables de predicción incluían año y mes de muestreo. Los datos de la CPUE de las redes de enmalle sugerían la presencia de una tendencia ascendente en la abundancia en el periodo 2008-2010, mientras que en el análisis del conjunto de datos de palangre no se identificó ninguna tendencia particular.*

KEYWORDS

Swordfish Xiphias gladius, CPUE, Gillnet, Longline, Eastern Mediterranean

1. Introduction

Swordfish (*Xiphias gladius*) is a large, pelagic, oceanodromous species of high commercial value that is heavily exploited in the Atlantic Ocean and the Mediterranean Sea. It migrates toward temperate or cold waters in the summer and back to warm waters in the fall at a depth range of 0-800 m (Tserpes *et al*., 2003; Froese and Pauly, 2014).

The exact time when swordfish fishery starts in Turkey is unknown. However Turkish swordfish fishery dates back to XVIIth century (Akyol and Ceyhan, 2011). Nowadays, the longline and harpoon has been using to catch swordfish, although the swordfish fishery was performed by gillnet, longline, trap and harpoon in the past. The catch statistics indicated that there were unstable catch amounts between 7 tons in 1976 and 589 tons in 1988 (FAO, 2011) in Turkish swordfish fishery. After banning the Turkish gillnet fishery in July 2011, the catch statistics indicated that there were dramatically decreasing in catch amounts of swordfish. In 2012, the catch amount of swordfish was only 79.7 tons (TUIK, 2013).

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The main goal of the present work is to estimate annual standardized abundance indices based on commercial catch per unit effort (CPUE) data series obtained from the Turkish swordfish fishing fleet.

2. Material and Methods

Data were obtained from the Turkish swordfish fishery fleet. Information on catch in number of individuals as well as round weight (kg) per set, effort (km of net and number of hook), was collected for years 2008- 2013.

CPUE data were expressed both in terms of weight and number (kg/1000 hooks and N/1000 hooks for longlines; kg/km, and N/km for gillnets) and were analyzed, separately for each fleet, by means of Generalized linear modelling (GLM) techniques (McCullagh and Nelder 1983). Based on the deviance residuals plot, models assuming a Gamma error structure with a log link function were found to be the most appropriate for the longline data. For the gillnet data set, which included a relative a relative small percentage of zero values (~12%), models assuming a negative binomial error were more suitable. The models included the main effects of year and month and the general form of the GLM used was:

$$CPUE \sim c + Year + Month + e,$$

where c = constant and e = error term

Model fitting was accomplished under the R language environment (R Development Core Team, 2013) and statistical inference was based on the 95% confidence level.

3. Results and Discussion

3.1 Gillnet Fishery

A total of 133 data records were analyzed that were collected in the period 2008-2010. In order to compliance with UN and EU binding resolutions, Pelagic gillnet in Turkey was banned. Therefore, the fleet stopped its activity in July 2011.

There is no any outstanding feature in the deviance residual plot suggesting that the model is inappropriate for the observations, both for the weight and number expressed CPUEs (**Figure 1**). The analysis of deviance tables indicated that in both cases the year effect was significant **(Table 1**) with a clearly increasing trend **(Figure 2)**.

3.2 Longline Fishery

The Turkish sub-surface longline fishery for swordfish is mostly carried out in Fethiye region towards to Kaş (Antalya) and some Sığacık Bay (southern Aegean Sea). The fishing usually performs at night time during the whole year (except the closed seasons between 1 October and 30 November, and 15 February and 15 March). A total of 50 records collected from 2008-2013 were analyzed.

There is no any outstanding feature in the deviance residual plot suggesting that the model is inappropriate for the observations, both for the weight and number expressed CPUEs (**Figure 3**). The analysis of deviance tables indicated that in both cases the year effect was significant **(Table 2)** but without any particular trend **(Figure 4)**.

The estimated standardized CPUE indices by year, for both gears and CPUE types, are shown on **Table 3**.

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Table 1. Analysis of deviance for the GLMs fitted to the gillnet CPUE data (weight and number).

GN_W			
	Chisq	*Df*	*Pr(>Chisq)*
year	6.347	2	0.04187
month	9.284	5	0.09827

GN_N			
	Chisq	*Df*	*Pr(>Chisq)*
year	12.161	2	0.002288
month	15.506	5	0.008404

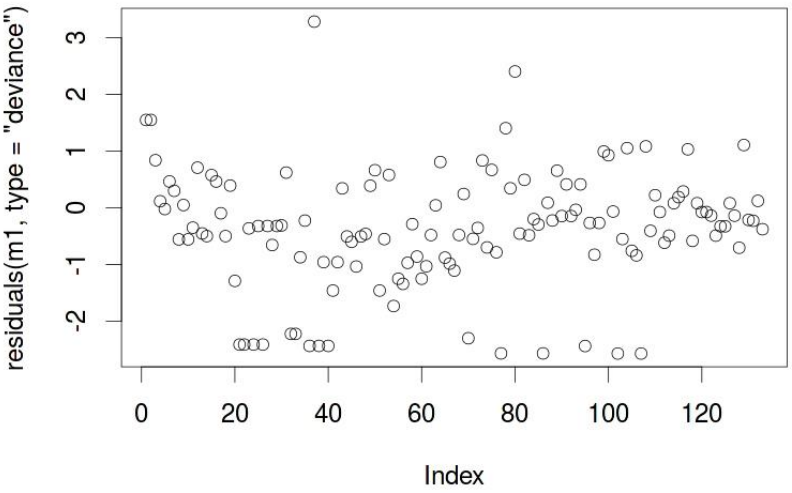
Table 2. Analysis of deviance for the GLMs fitted to the longline CPUE data (weight and number).

CPUE LL-W				
	SS	*Df*	*F*	*Pr(>F)*
Year	9.4165	5	5.3922	0.000988
Month	5.4890	8	1.9645	0.082891
Residuals	11.5256	33		

CPUE LL-N				
	SS	*Df*	*F*	*Pr(>F)*
Year	5.8003	5	3.1220	0.02044
Month	6.7282	8	2.2634	0.04737
Residuals	12.2621	33		

Table 3. Standardized abundance indices by year and fishing gear. Indices are expressed in terms of kg/1000hooks and number/1000 hooks for the longliners (LL) and kg/km and number/km of nets for the gillnetters (GN).

Year	LL_W	LL_N	GN_W	GN_N
2008	135.71869	13.312669	18.78086	0.2889370
2009	479.48804	19.299198	30.51493	0.7605431
2010	157.65916	16.021010	46.53470	0.9673352
2011	31.23452	4.851867		
2012	74.47047	4.694949		
2013	269.74072	11.497605		



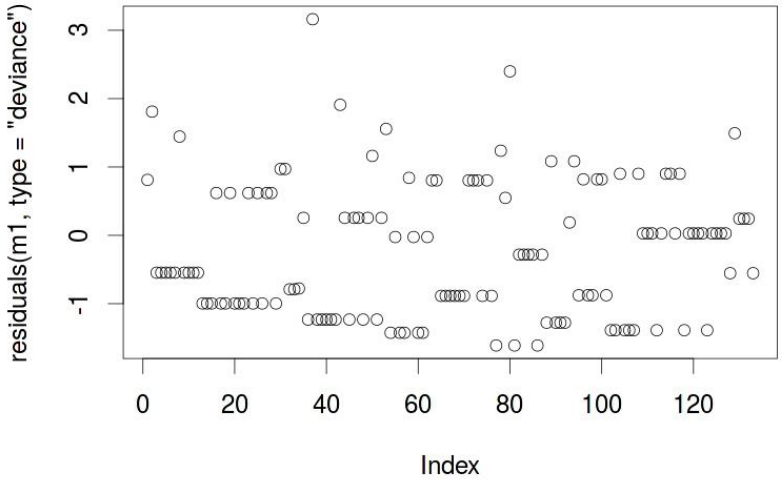


Figure 1. Residual deviance of the generalized linear models fitted to the gillnet CPUE data expressed in terms of kg/km (top) and N/km (bottom) of net.

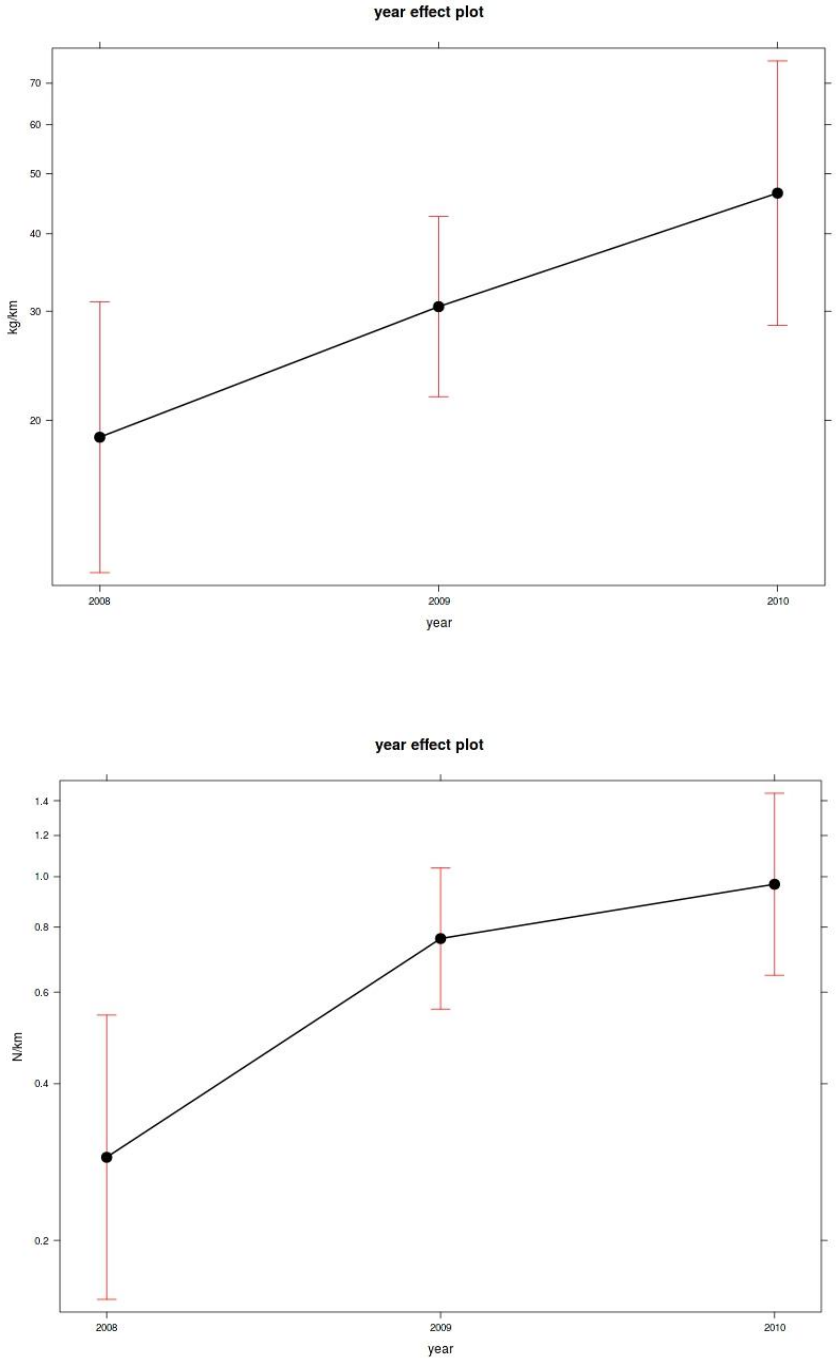


Figure 2. Generalized linear model derived effect of year on the gillnet CPUE data expressed in terms of kg/km (top) and N/km (bottom) of net. Vertical lines indicate 95% confidence intervals of the corresponding estimates.

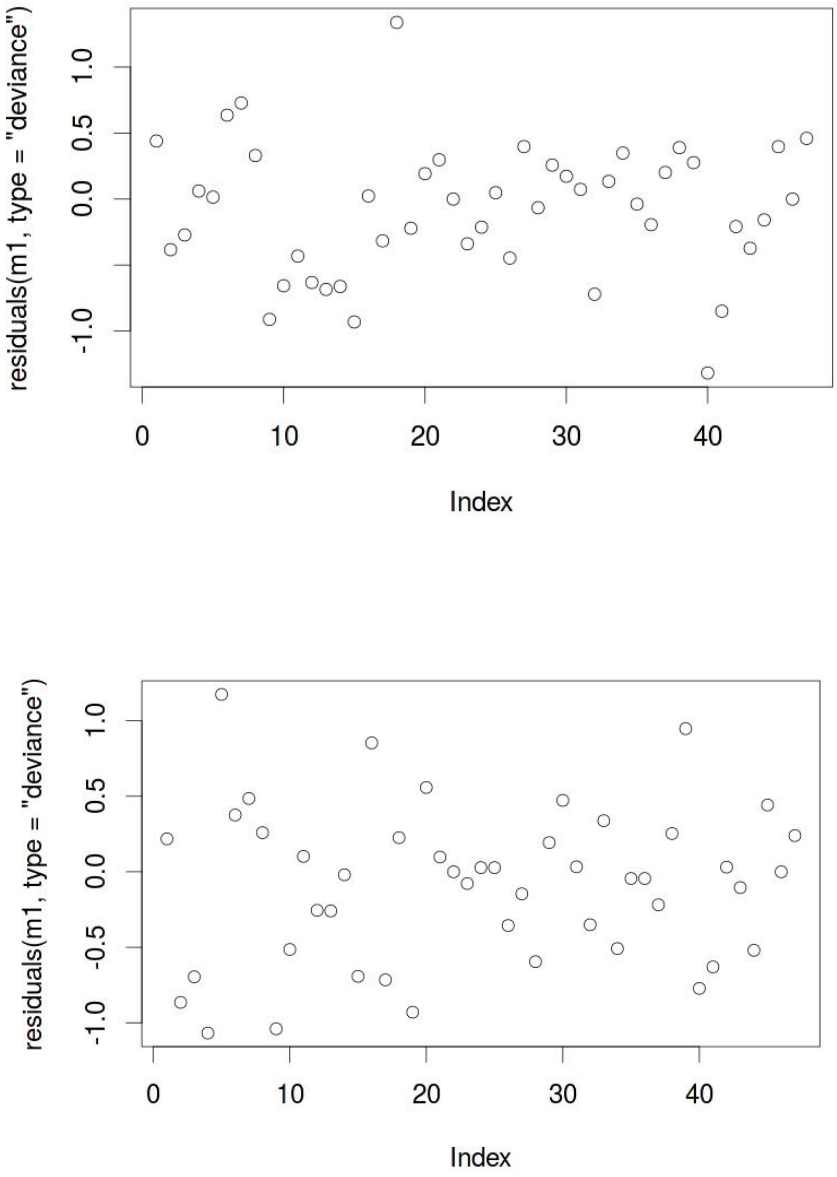


Figure 3. Residual deviance of the generalized linear models fitted to the longline CPUE data expressed in terms of kg/1000 hooks (top) and N/1000 hooks (bottom) respectively.

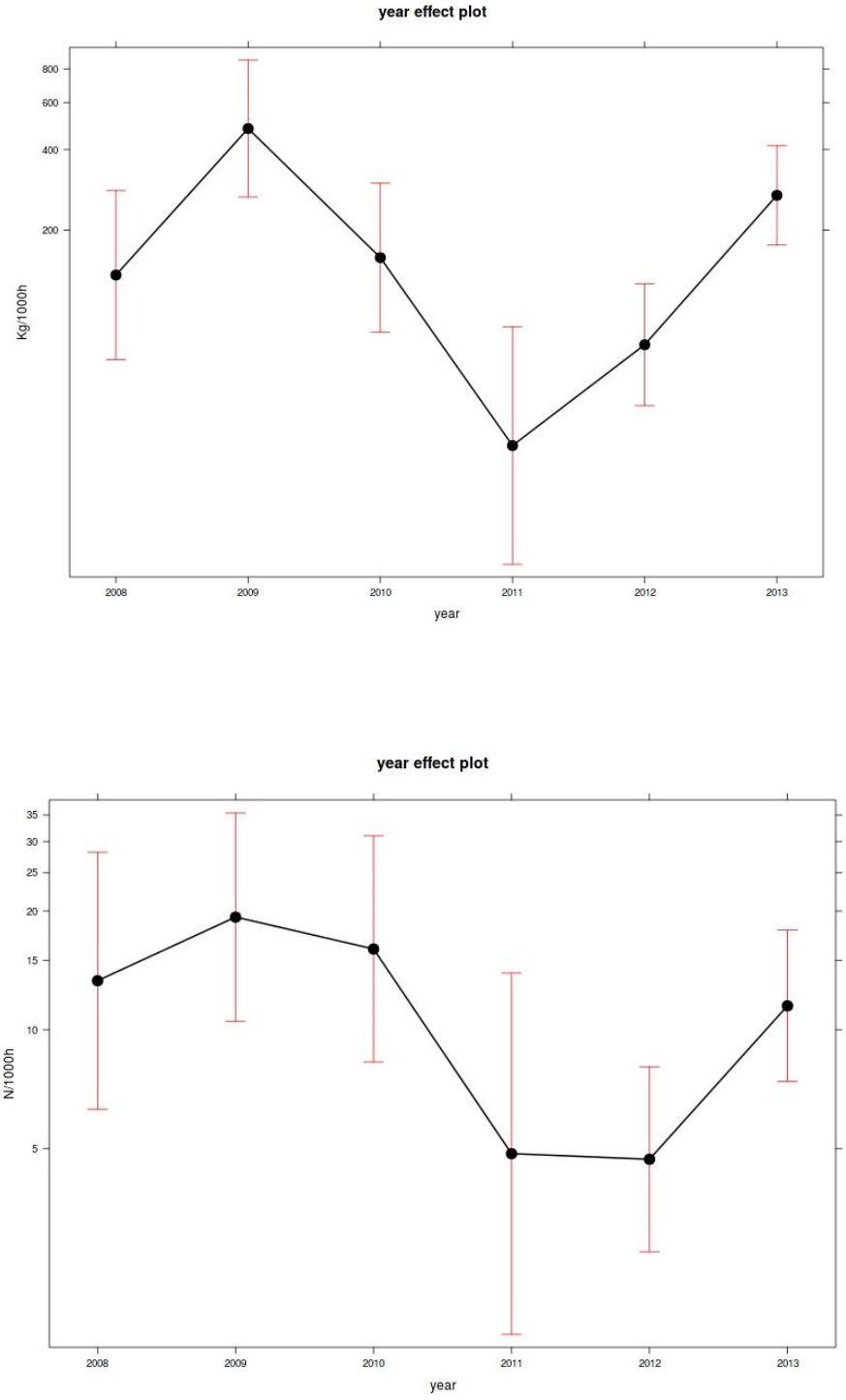


Figure 4. Generalized linear model derived effect of year on the longline. CPUE data expressed in terms of kg/1000 hooks (top) and N/1000 hooks (bottom) respectively. Vertical lines indicate 95% confidence intervals of the corresponding estimates.